Indicators of Exposure and Risk (The Missing Links?)

Tom Burke
Johns Hopkins School of Public Health

Indicator (EPA)

- “An environmental indicator is a numerical value that helps provide insight into the state of the environment or human health. Indicators are developed based on quantitative measurements or statistics of environmental condition that are tracked over time. Environmental indicators can be developed and used at a wide variety of geographic scales, from local to regional to national levels.”

A review… Steps of Risk Assessment

- Problem Formulation
- Hazard Identification
- Dose response
- Exposure Assessment
- Risk Characterization

The Role of Exposure Indicators

- Exposure indicators are critical to understanding environmental health of a community
- Exposure indicators are also essential in the risk assessment process

Uses of Biomonitoring

- Measure amount of chemical absorbed into the body
- Provide a measure of individual or population exposure levels
- Evaluate health effects
- Identify those at highest risk
- Track trends
- Guide prevention strategies

Sampling Questions

- Are valid methods used?
- Adequate number of samples?
- Level of detection appropriate?
- Laboratory methods assured?

Population Questions

- Highly exposed subpopulations identified?
- Sensitive subpopulations?
- Variability in exposure measured?
- Representative sample of the population?

Exposure Data Questions

- Are data geographically relevant?
- Are data temporally appropriate?
- Relevant pathways measured?
- Do data measure trends in exposure?

Ideal Biomarkers

- *Be Persistent* - have a long half-life;
- *Be Easily Collected* - collected using non-invasive procedures that present only minor procedural difficulties in collection, transport, storage, and analysis;
- *Be Linked to Disease* - display exposure, indicate effect, and establish a link between them;
- *Have a Large Sample* - to examine the distribution of the biomarker in the population and to establish links between the biomarker and effect, it is important that the biomarker found in a substantial fraction of the population.
- *Have Broad Spatial Distribution and Temporal Occurrence* - a complete spatial and temporal understanding of the exposure/health outcome distribution;
- *Have Sensitivity* - sufficiently sensitive to give information on differences in populations from different regions and over time scales of interest, e.g., seasonal or long-term, secular trends.

- (Groopman and Kensler 2005; Metcalf and Orloff 2004; Schulte and Mazzuckelli 1991; WHO 1993)

The Exposure Challenge: Where is it coming from?

- We still need improved environmental sampling measures
- Biomonitoring does not tell us about the source of the contaminant

We need to measure contributions from different sources and pathways

Air levels

Water levels

Soil/dust levels

Food levels

Nutritional status

Lifestyle factors

Personal habits

Genetic factors

Measured levels of toxicants in people

MANY OTHER FACTORS

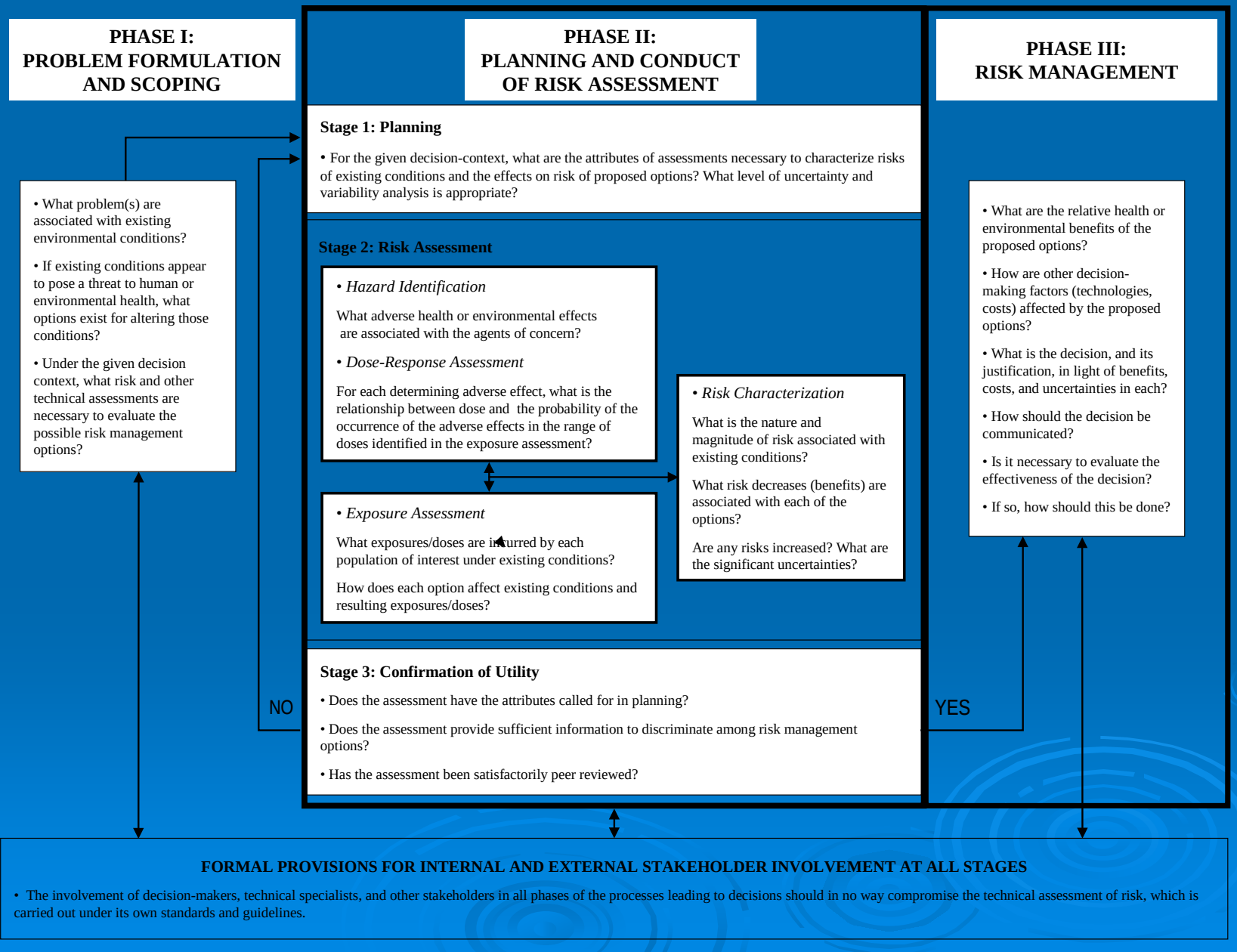
From Exposure to Health Risks

- Environmental concentrations are limited as measures of actual exposure
- Biomarkers provide an important link to dose
- Number of pollutants, mixtures, multiple pathways, cumulative exposure
- Risk assessment is an important step toward measuring health impacts

Application of Risk Assessment Indicators

- Provide a public health context to exposure indicators
- Identify key health endpoints
- Can be compared to health based “bright lines” … RfD, MCLs
- Provide estimates of community risk
- Risk assessment can guide selection of community health indicators

The Silver Book and Risk



Elements of HIA (NAS 2011)

The committee recommended a six-step framework that includes the following elements:

- Screening
- Scoping
- Assessment
- Recommendations
- Reporting
- Monitoring and Evaluation

Future Directions

- Our future success will depend upon the development of meaningful indicators for exposure, risk, and health impact
- Continuum of indicators – asking the right questions
- Release and emissions - environmental monitoring – exposure - risk – community health
- Refinement of indicators for risk assessment and health impact assessment
- Links to prevention, interventions, and policy evaluation

Indicator Linkages